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(54) **REMOTE CONTROL SYSTEM AND MOVING MACHINE THEREOF**

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A63H 30/04 (2006.01)

(52) **U.S. Cl.** **701/2**; 701/117; 446/456

(58) **Field of Classification Search** .... None
See application file for complete search history.

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(57) **ABSTRACT**

A remote control system to remote control a plurality of moving machines and to cause interaction based on communication among the moving machines without complexity and an increase in electric power consumption. A transmitting device of data containing operation control information and communication control information, and a device which specifies a transmission timing from the data from another transmitter and a transmission schedule, are provided. A controlling device controls operation on the basis of operation control information and transmission to another moving machine on the basis of communication control information at the time of receipt from the transmitter and executes a predetermined process at the time of receipt from another moving machine. The controlling device specifies a self transmission timing from the data from the transmitter and the transmission schedule, and transmits it. A transmission schedule stipulates respective transmission timings such that they do not overlap.

12 Claims, 9 Drawing Sheets

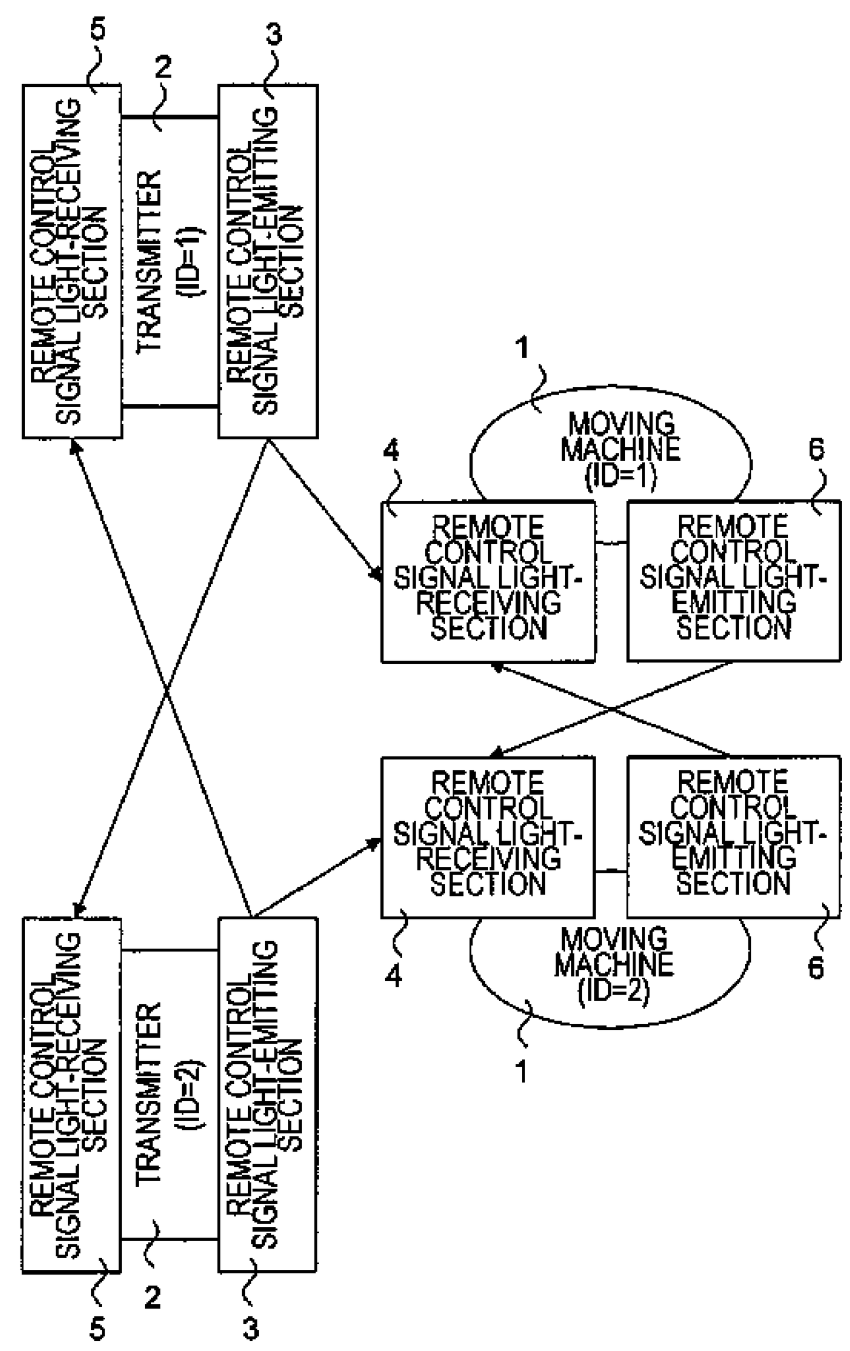


FIG.1

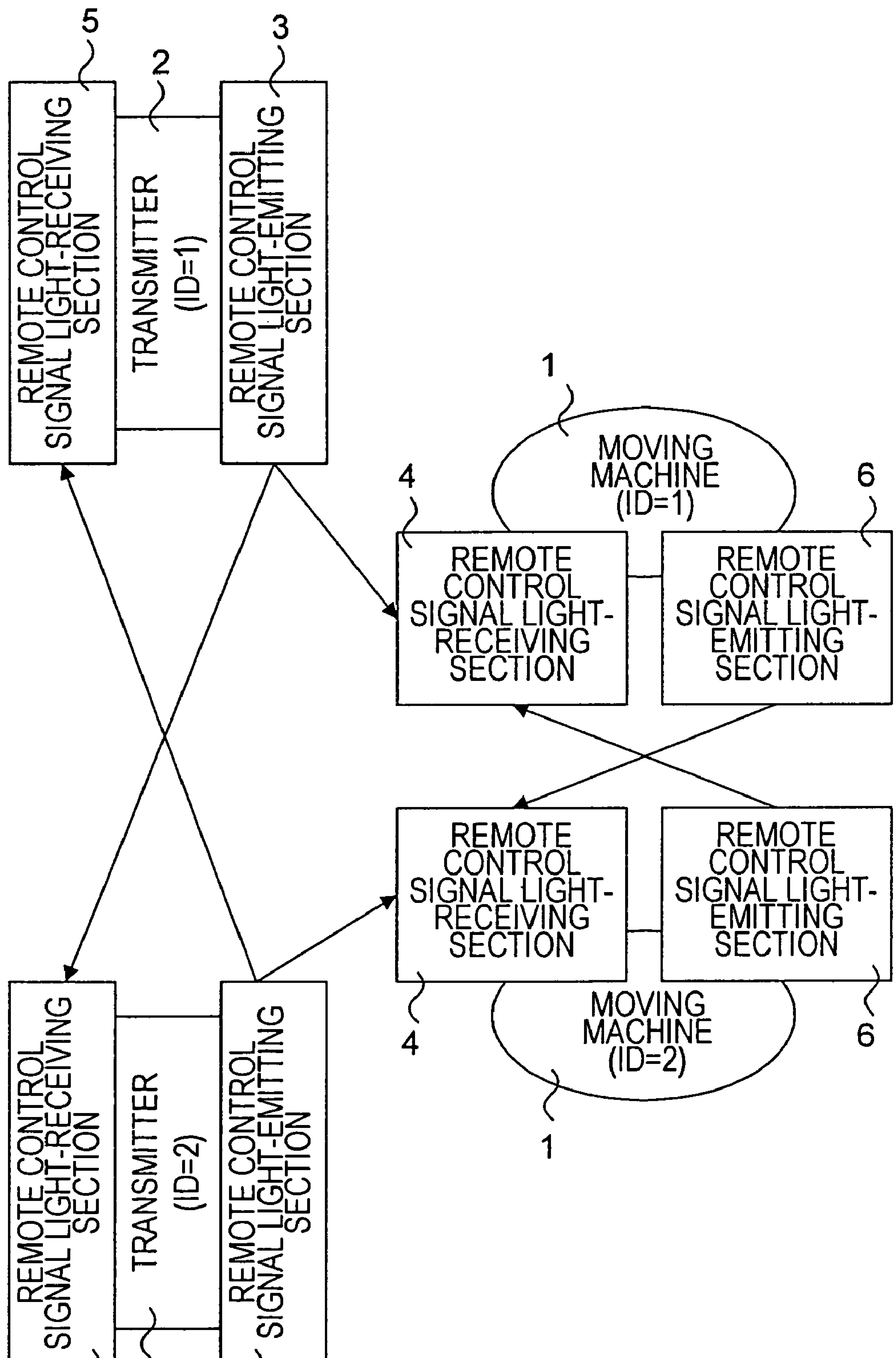

5
2
3
REMOTE CONTROL SIGNAL LIGHT-RECEIVING SECTION
TRANSMITTER (ID=1)
REMOTE CONTROL SIGNAL LIGHT-EMITTING SECTION
1
MOVING MACHINE (ID=1)
4
6
REMOTE CONTROL SIGNAL LIGHT-RECEIVING SECTION
REMOTE CONTROL SIGNAL LIGHT-EMITTING SECTION
REMOTE CONTROL SIGNAL LIGHT-RECEIVING SECTION
REMOTE CONTROL SIGNAL LIGHT-EMITTING SECTION
4
MOVING MACHINE (ID=2)
6
1
REMOTE CONTROL SIGNAL LIGHT-RECEIVING SECTION
TRANSMITTER (ID=2)
REMOTE CONTROL SIGNAL LIGHT-EMITTING SECTION
5
2
3

FIG.2A

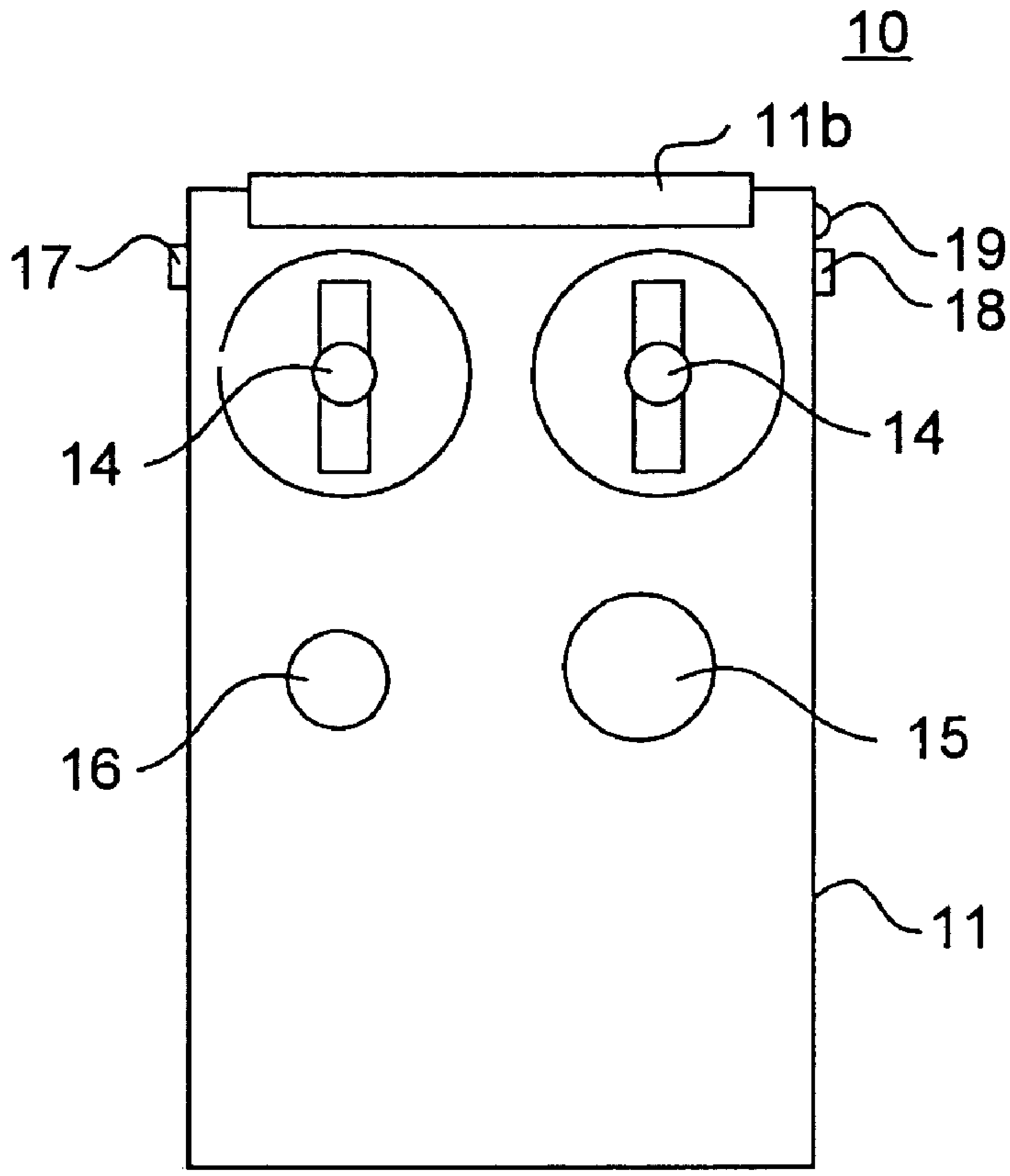


FIG.2B

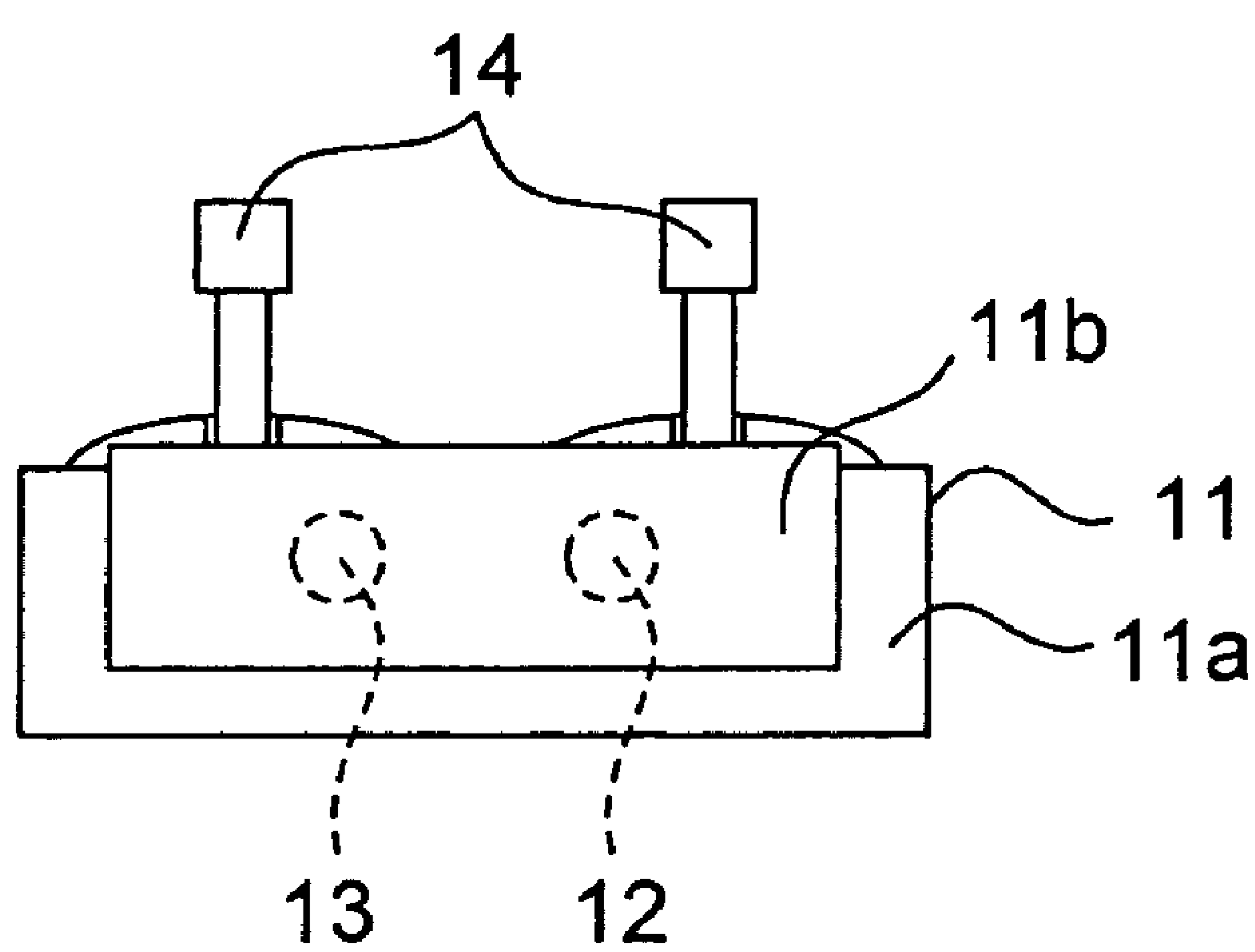
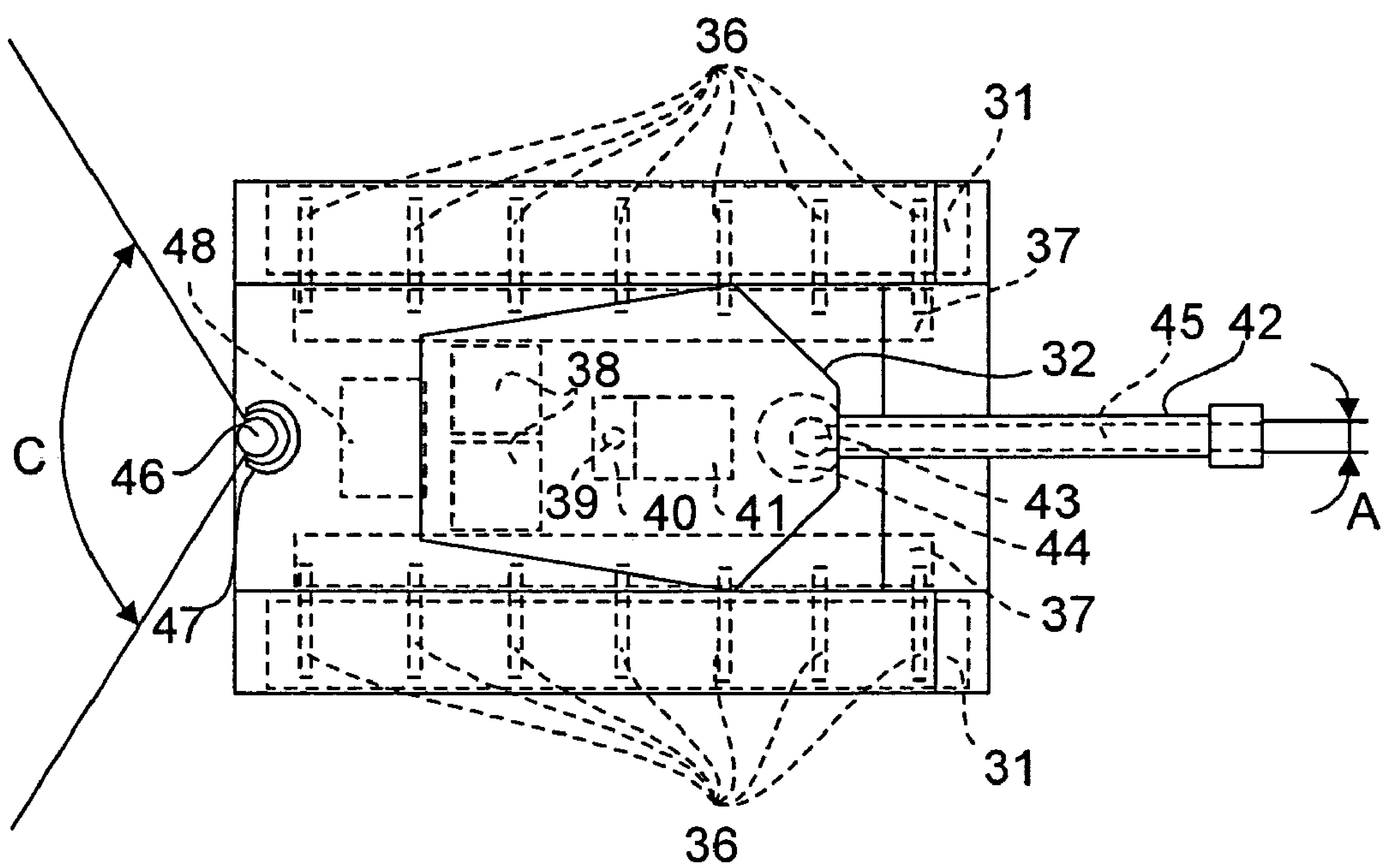


FIG.3

(A)


30
36
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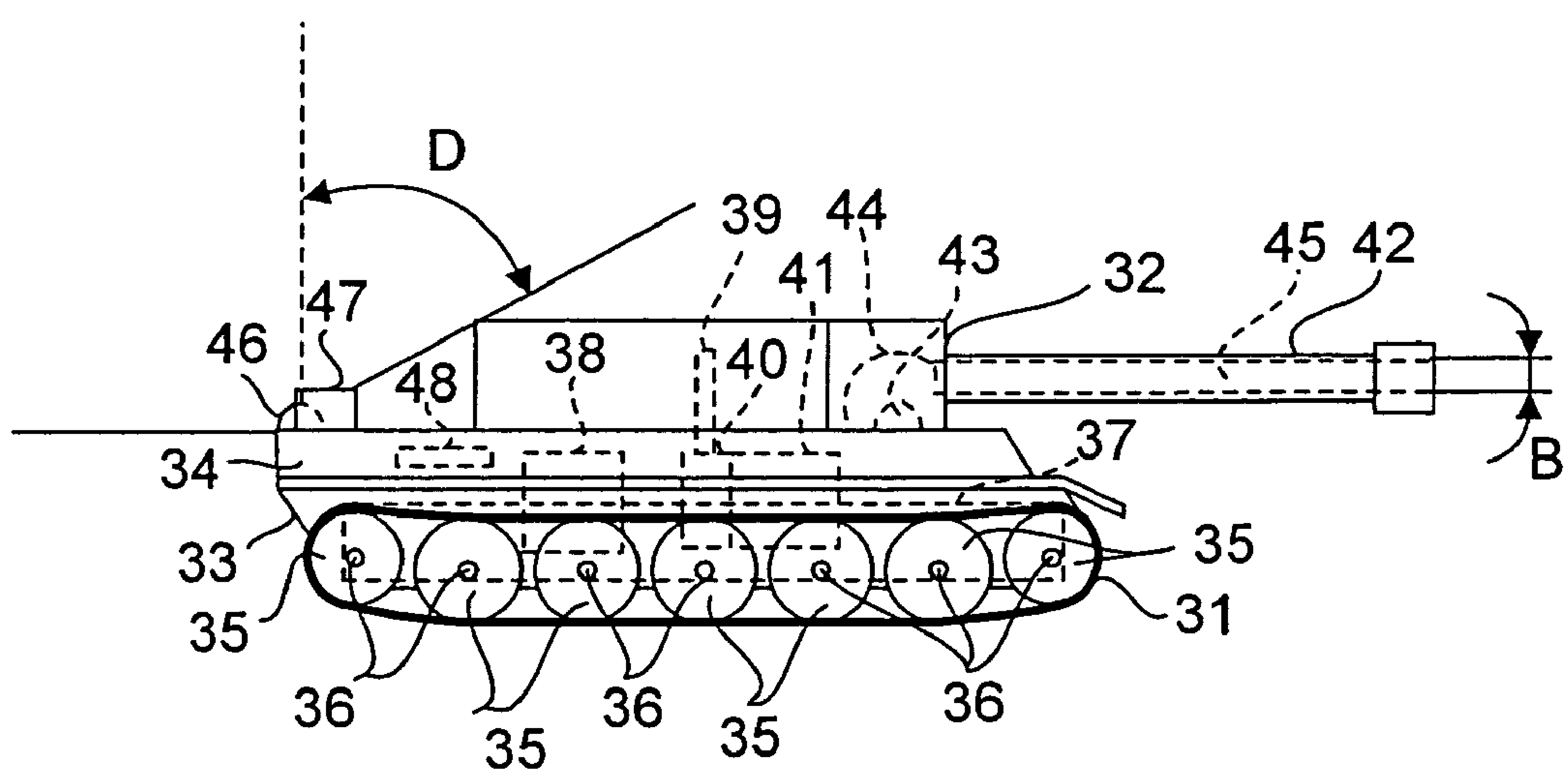
37
45 42
32
38
C
46
39
40
41
43
A
44
37
47
31
36

(B)


D
39
44
43
32
45 42
47
41
46
48
38
40
34
37
B
33
35
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35
36
36
35
36
35

FIG.4

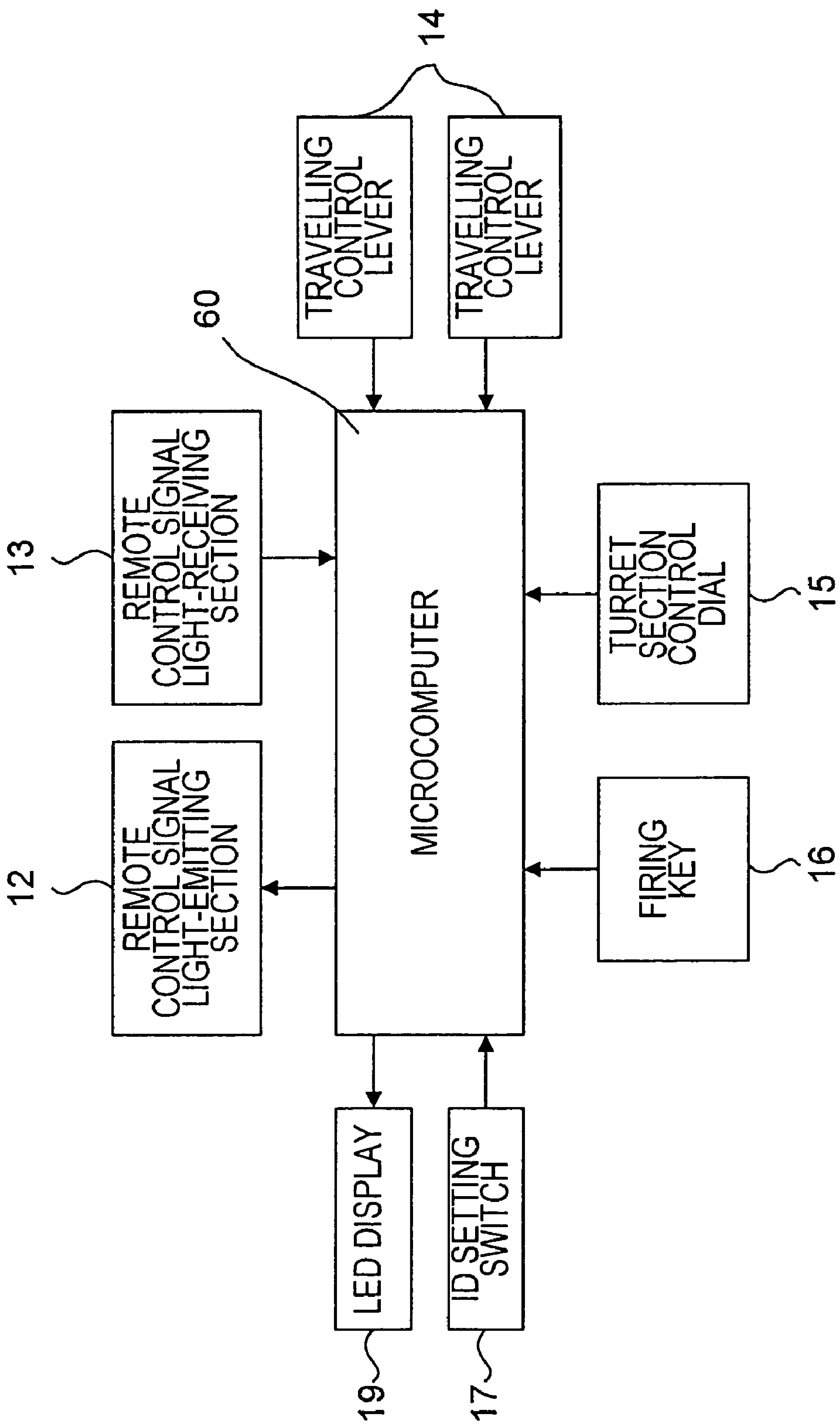

14
TRAVELLING CONTROL LEVER
TRAVELLING CONTROL LEVER
60
13
REMOTE CONTROL SIGNAL LIGHT-RECEIVING SECTION
12
REMOTE CONTROL SIGNAL LIGHT-EMITTING SECTION
MICROCOMPUTER
TURRET SECTION CONTROL DIAL
15
FIRING KEY
16
LED DISPLAY
ID SETTING SWITCH
19
17

FIG.5

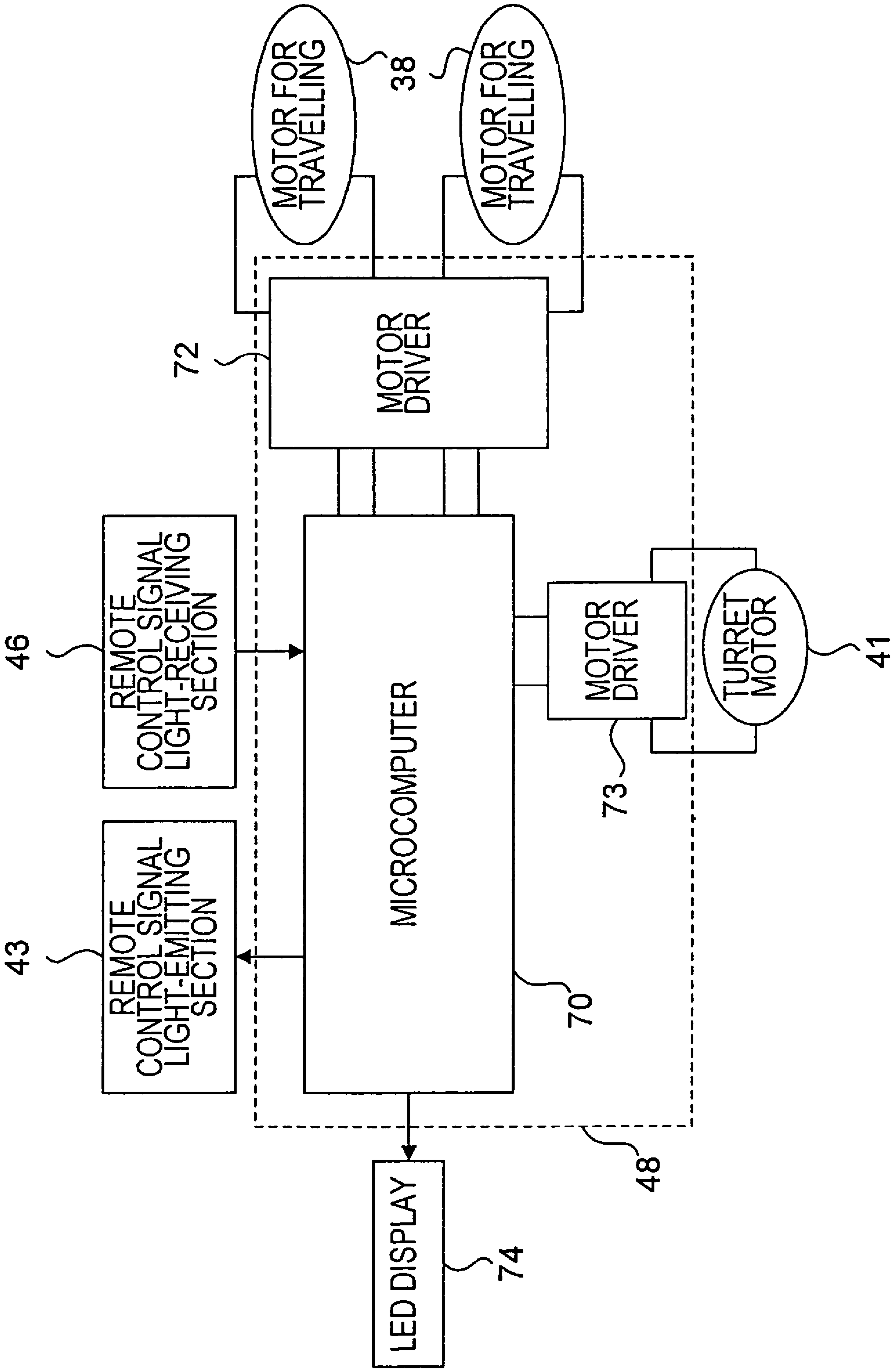

MOTOR FOR TRAVELLING
38
MOTOR FOR TRAVELLING
72
MOTOR DRIVER
46
REMOTE CONTROL SIGNAL LIGHT-RECEIVING SECTION
MICROCOMPUTER
MOTOR DRIVER
TURRET MOTOR
41
73
43
REMOTE CONTROL SIGNAL LIGHT-EMITTING SECTION
70
48
LED DISPLAY
74

FIG.6

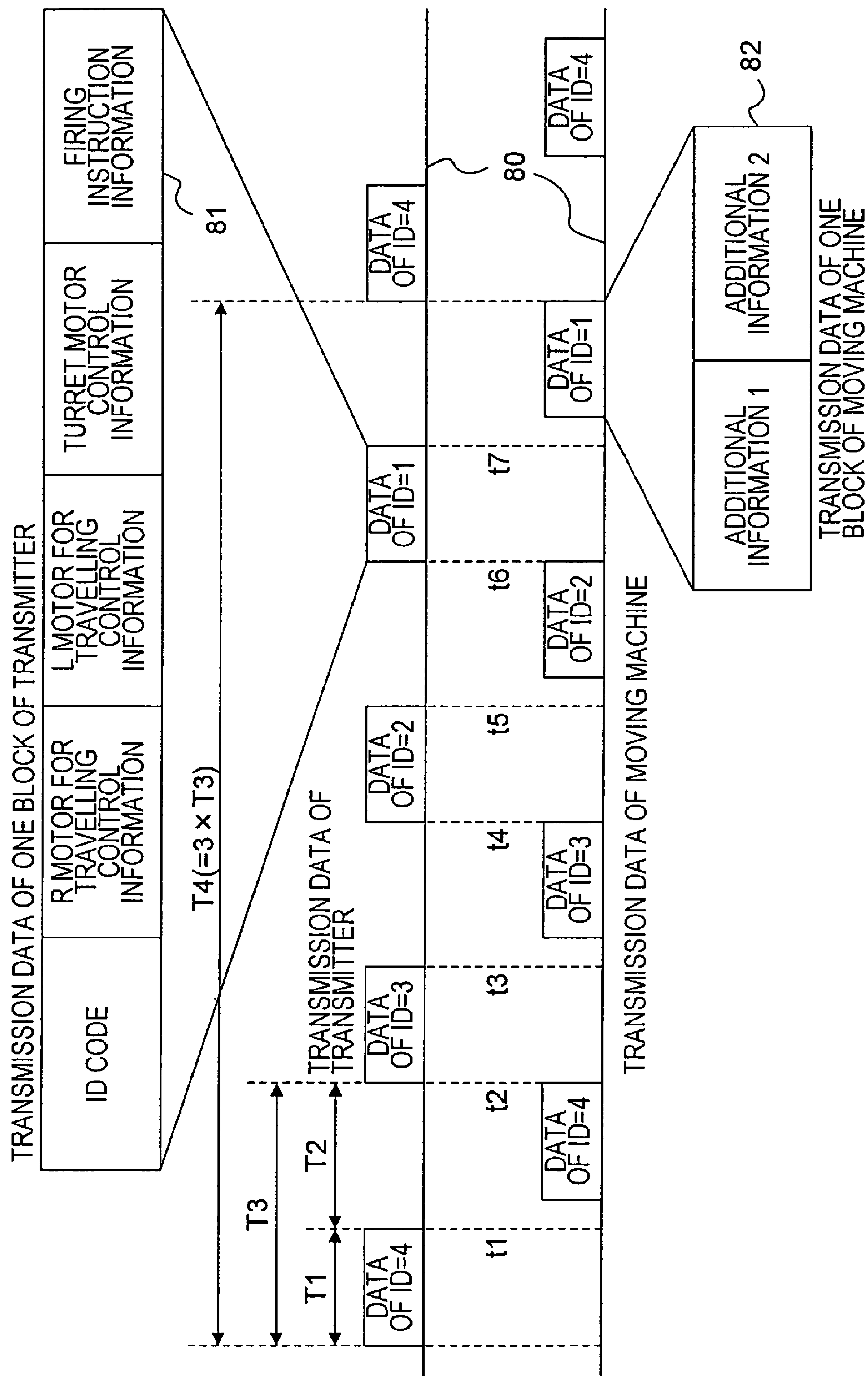

TRANSMISSION DATA OF ONE BLOCK OF TRANSMITTER
ID CODE
R MOTOR FOR TRAVELLING CONTROL INFORMATION
L MOTOR FOR TRAVELLING CONTROL INFORMATION
TURRET MOTOR CONTROL INFORMATION
FIRING INSTRUCTION INFORMATION
81
T4(=3 × T3)
T3
T1
T2
TRANSMISSION DATA OF TRANSMITTER
DATA OF ID=4
DATA OF ID=3
DATA OF ID=2
DATA OF ID=1
DATA OF ID=4
t1
t2
t3
t4
t5
t6
t7
80
DATA OF ID=4
DATA OF ID=3
DATA OF ID=2
DATA OF ID=1
DATA OF ID=4
TRANSMISSION DATA OF MOVING MACHINE
82
ADDITIONAL INFORMATION 1
ADDITIONAL INFORMATION 2
TRANSMISSION DATA OF ONE BLOCK OF MOVING MACHINE

FIG.7

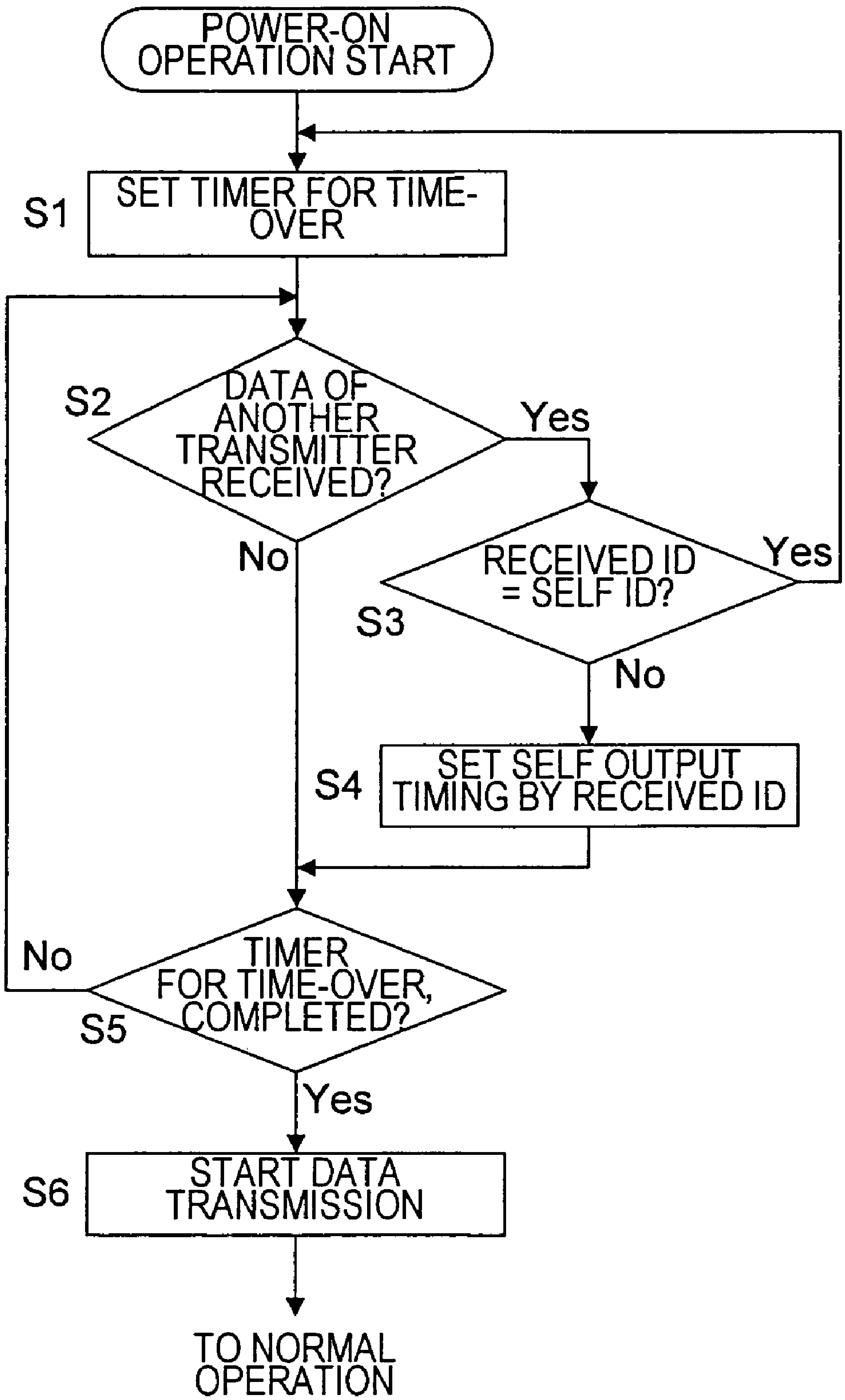

POWER-ON OPERATION START
S1
SET TIMER FOR TIME-OVER
S2
DATA OF ANOTHER TRANSMITTER RECEIVED?
Yes
No
S3
RECEIVED ID = SELF ID?
Yes
No
S4
SET SELF OUTPUT TIMING BY RECEIVED ID
S5
TIMER FOR TIME-OVER, COMPLETED?
No
Yes
S6
START DATA TRANSMISSION
TO NORMAL OPERATION

FIG.8

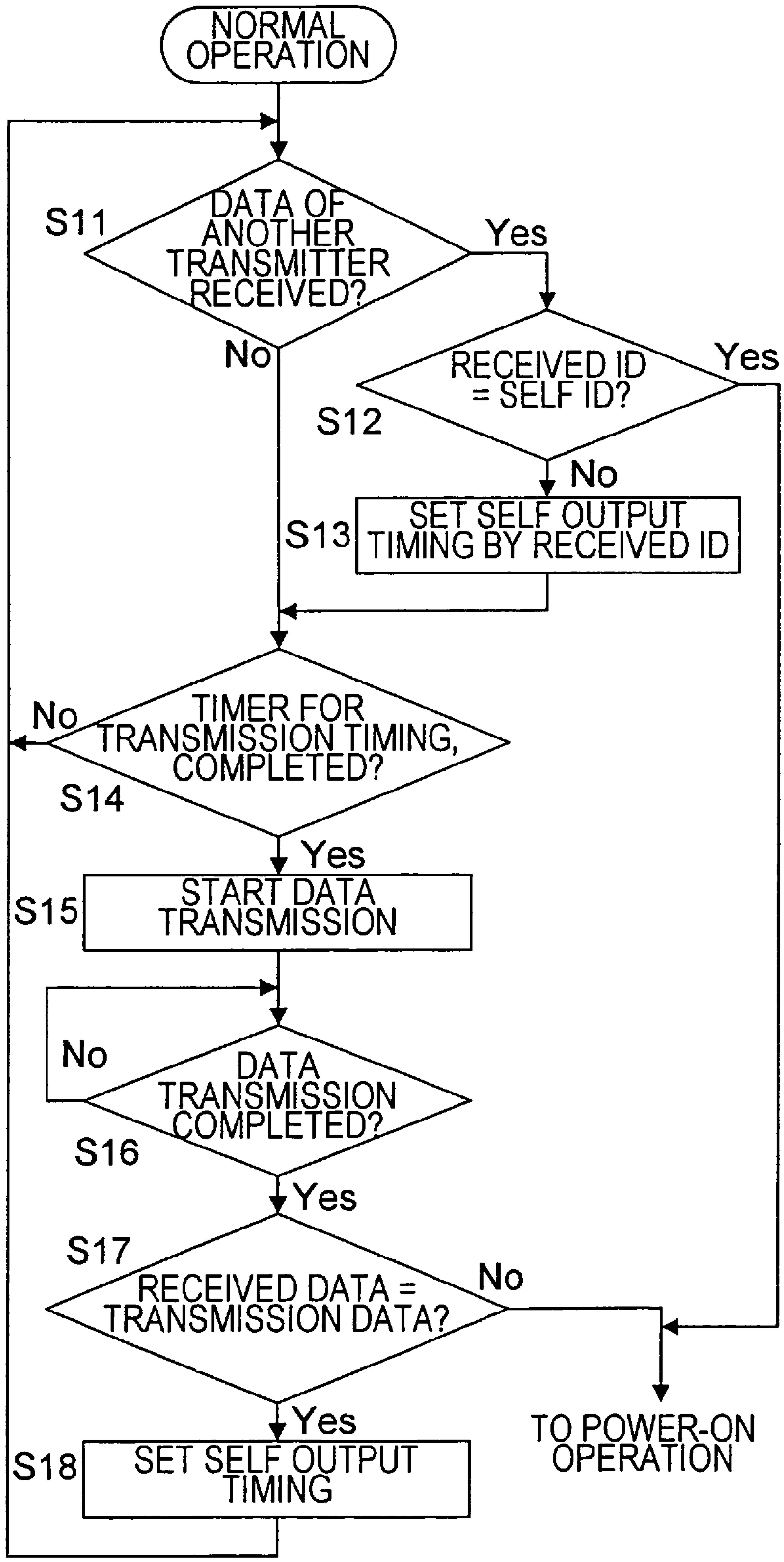
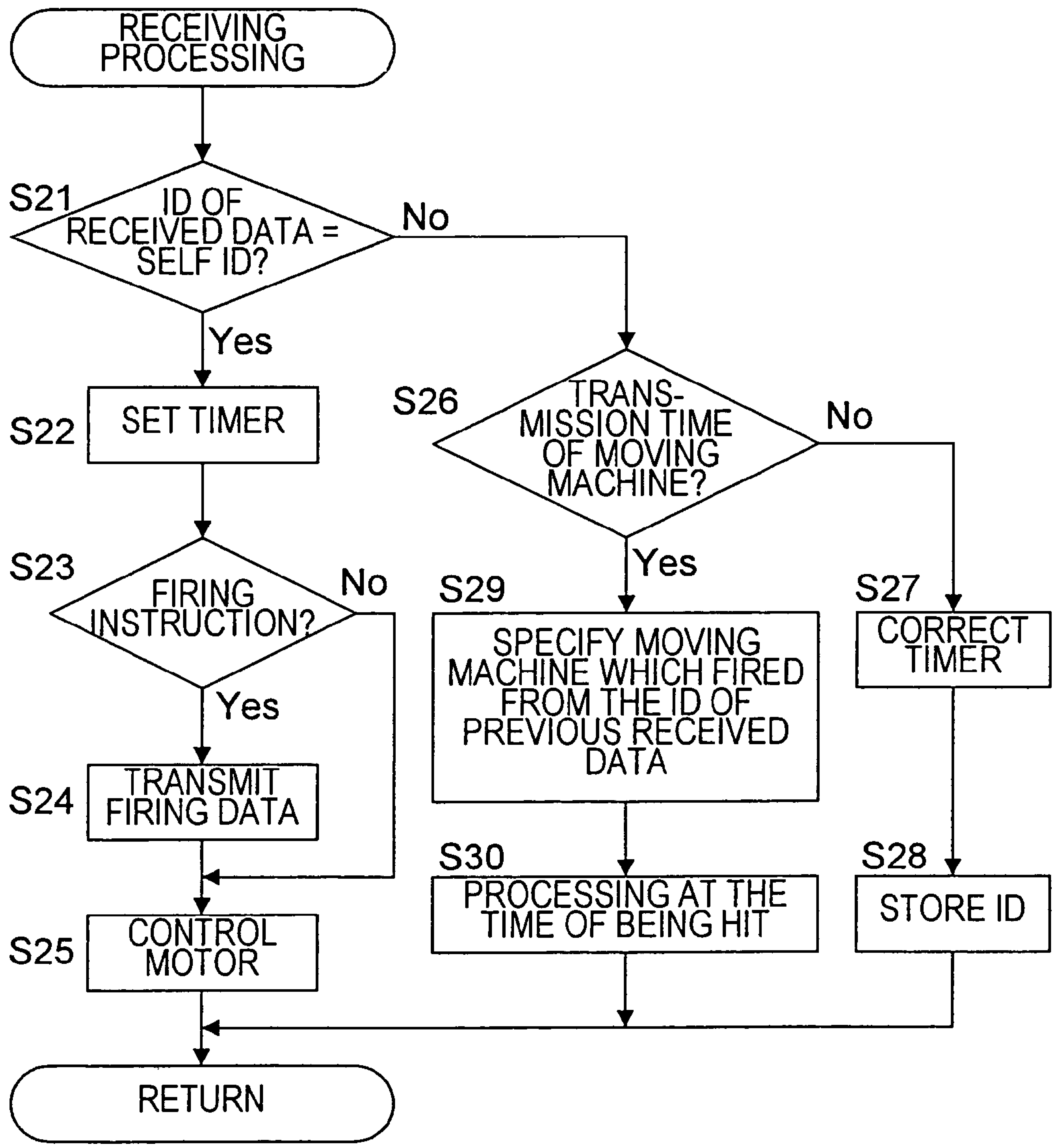

NORMAL OPERATION
S11
DATA OF ANOTHER TRANSMITTER RECEIVED?
Yes
No
RECEIVED ID = SELF ID?
Yes
S12
No
S13
SET SELF OUTPUT TIMING BY RECEIVED ID
No
TIMER FOR TRANSMISSION TIMING, COMPLETED?
S14
Yes
S15
START DATA TRANSMISSION
No
DATA TRANSMISSION COMPLETED?
S16
Yes
S17
RECEIVED DATA = TRANSMISSION DATA?
No
Yes
TO POWER-ON OPERATION
S18
SET SELF OUTPUT TIMING

FIG.9


RECEIVING PROCESSING
S21
ID OF RECEIVED DATA = SELF ID?
No
Yes
S22
SET TIMER
S23
FIRING INSTRUCTION?
No
Yes
S24
TRANSMIT FIRING DATA
S25
CONTROL MOTOR
S26
TRANS-MISSION TIME OF MOVING MACHINE?
No
Yes
S29
SPECIFY MOVING MACHINE WHICH FIRED FROM THE ID OF PREVIOUS RECEIVED DATA
S30
PROCESSING AT THE TIME OF BEING HIT
S27
CORRECT TIMER
S28
STORE ID
RETURN

REMOTE CONTROL SYSTEM AND MOVING MACHINE THEREOF

TECHNICAL FIELD

The present invention relates to a system in which a moving machine such as an automobile, a robot, or the like is remote-controlled and in particular, to a remote control system in which a plurality of moving machines are controlled at the same place and at the same time and which is suitable for a case in which there is a need to cause interaction based on communication between the moving machines, and to a moving machine thereof.

BACKGROUND OF THE INVENTION

When a plurality of moving machines are remote-controlled at the same place by utilizing infrared radiation or radio waves and communication is carried out between the moving machines by utilizing infrared radiation or radio waves, signals transmitted from the transmitter to the moving machine and signals between the moving machines interfere with each other, and therefore, there is the fear that accurate control and communication will be difficult. As a technique solving such a problem, for example, the system disclosed in Japanese Patent No. 2713603 is well-known. In this system, a transmitter has a transmitting device which transmits, by radio waves, data for remote-controlling a corresponding moving machine. Further, the moving machine has a transmitting device which transmits, by infrared radiation, data for communicating with another moving machine, a device which receives data by radio waves, and a device which receives data by infrared radiation. In accordance therewith, a remote control operation system is realized in which signals transmitted from the transmitter and signals from the moving machine are prepared from interfering with each other, and a plurality of moving machines are remote-controlled at a same place, and communication between the moving machines is carried out.

In the above-described remote control system, a moving machine needs two different receiving devices, which are a device which receives radio waves transmitted from a transmitter and a device which receives infrared radiation transmitted from another moving machine, and a processing system. Therefore, the drawbacks that the structure of the moving machine is complicated and the electric power consumption increases arise.

SUMMARY OF THE INVENTION

Here, the object of the present invention is to provide a remote control system in which a plurality of moving machines are remote-controlled without leading to complexity of the structure of the moving machine and an increase in electric power consumption, and which can cause interaction based on communication between the moving machines.

In order to solve the above problems, according to the present invention, there is provided a remote control system in which operations of a plurality of moving machines which are readied for a plurality of transmitters, respectively, are individually controlled by the plurality of transmitters and interaction is caused between the plurality of moving machines based on communication,

each of the plurality of transmitters comprising: an operation data preparing device which prepares operation data including identification information which is for identifying each of the plurality of transmitters and is unique to each of the plurality of transmitters, operation control information for controlling an operation of one of the plurality of moving machines, and communication control information for controlling the communication between the moving machines; an operation data transmitting device which transmits the operation data; an operation data receiving device which receives the operation data transmitted from another one of the plurality of transmitters; a transmission timing setting device which sets a transmission timing of self operation data on the basis of the identification information contained in the received operation data; and an operation data transmission controlling device which makes the data transmitting device transmit the operation data according to the set transmission timing,

each of the plurality of moving machines comprising: a communication data preparing device which prepares communication data for making another one of the plurality of moving machines execute a predetermined processing; a communication data transmitting device which transmits the communication data; a data receiving device which receives the operation data transmitted from each of the plurality of transmitters and the communication data transmitted from said another one of the plurality of moving machines; and a moving machine controlling device which, when the operation data containing the identification information unique to one of the plurality of transmitters corresponding to oneself is received, controls self operation on the basis of the operation control information contained in the received operation data, and controls preparation and transmission of the communication data on the basis of the communication control information contained in the received operation data, and which, when the communication data from said another one of the plurality of moving machines is received, executes the predetermined processing corresponding to the received communication data,

wherein for the plurality of transmitters and moving machines, a common data transmission schedule, which is stipulated such that the transmission timing of each of the operation data and the communication data does not overlap each other, is set, the transmission timing setting device of each of the plurality of transmitters refers to the identification information contained in the operation data from said another one of the plurality of transmitters, and specifies the transmission timing of self operation data stipulated by the data transmission schedule, and the moving machine controlling device refers to a receiving timing of the operation data transmitted from at least one of the plurality of transmitters, and specifies a transmission timing of self communication data stipulated by the data transmission schedule, and makes the communication data transmitting device transmit the communication data according to the specified transmission timing.

According to the remote control system of the present invention, each transmitter, by receiving data transmitted from another transmitter, and each moving machine, by referring to the receipt timing of data transmitted from each transmitter, can transmit self data according to a data transmission schedule provided such that transmission timings of each transmitter and each moving machine do not overlap. Accordingly, the data from each transmitter and the data from each moving machine can be transmitted on the same carrier signal, and sharing, at each moving machine, of a receiving device and a processing system of the signals from the transmitter and the signals from the moving machine, can be advanced. In accordance therewith, without leading to complexity of the structure of the moving machine and an increase in electric power consumption, a plurality of moving machines can be remote-controlled and interaction based on communication can be caused between the moving machines.

Further, the remote control system of the present invention can include the following modes.

The data transmission schedule may be stipulated such that the transmission timing of each of the operation data and the communication data cyclically arrives in a predetermined order.

In this way, by only stipulating the transmission schedule of one period of operation data and communication data, each transmitter and each moving machine can specify a period in which the self data can be transmitted. Further, because data transmission is carried out each period, even if one part of the transmitters cuts off data transmission in the midst thereof, another transmitter and moving machine can specify the period allocated to themselves and transmit data.

In each cycle, periods in which the plurality of transmitters are allowed to transmit the operation data, respectively, may be stipulated so as to have time lengths equal to each other, and periods in which the plurality of moving machines are allowed to transmit the communication data, respectively, may be stipulated so as to have time lengths equal to each other.

In this way, by only stipulating the order of data transmission of each transmitter and each moving machine in a predetermined period, each transmitter and each moving machine can specify a period in which the self data can be transmitted. For example, when a time length of the transmission period of the transmitter is T**1** and a time length of the transmission period of the moving machine is T**2**, a transmitter and a moving machine, whose transmission timing is set after the ith transmitter and the jth moving machine as counted from the transmitter whose transmission timing is set to be first, may start transmission after T**1**×i+T**2**×j from the first transmission start time.

The data transmission schedule may be stipulated such that the transmission timing of the communication data of one of the plurality of moving machines arrives next after the transmission timing of the operation data of one of the plurality of transmitters which corresponds to said one of the plurality of moving machines.

In this way, merely by starting transmission of the self transmission data immediately after receiving operation data from the transmitter corresponding to oneself, the moving machine can carry out the transmission without overlapping on the transmission timings of the transmitter and the other moving machines.

When said one of the plurality of moving machines receives the communication data transmitted from another one of the plurality of moving machines, said one of the plurality of moving machines may specify said another one of the plurality of moving machines on the basis of the identification information contained in the operation data received immediately before receipt of the communication data transmitted from said another one of the plurality of transmitters.

In this case, even if identification information is not added to the transmission data, it can be judged from which of the moving machines the transmission data is transmitted. Therefore, information which can be added to one block of communication data can be reduced, or the transmission/receiving time data can be shortened by reducing one block of communication. Also, when the transmission timing of the moving machine next corresponding to the transmitter is set, only the identification information contained in the operation data received immediately before is held, and it may merely be referred to, and the burden on the hardware can be reduced.

When each of the plurality of moving machines receives the operation data transmitted from each of the plurality of transmitters or the communication data transmitted from each of the plurality of moving machines, each of the plurality of moving machines judges whether the received data is either of the operation data or the communication data by comparing a receiving timing of the received data and the transmission timing of each of the plurality of transmitters and each of the plurality of moving machines stipulated by the data transmission schedule.

In this case, there is no need to add to the data information for judging whether it is either of operation data or communication data, and information which can be added to one block of data can be reduced, or the transmission/receiving time can be shortened by reducing one block of data.

According to the present invention, there is provided a moving machine which is combined with a transmitter capable of transmitting operation data including identification information for identifying oneself, operation control information for controlling an operation of one of objects of control, and communication control information for controlling communication between said objects of control, and which is used as said one of the objects of control, the moving machine comprising: a communication data preparing device which prepares communication data making another moving machine execute a predetermined processing; a communication data transmitting device which transmits the communication data; a data receiving device which receives the operation data transmitted from the transmitter and the communication data transmitted from said another moving machine; and a moving machine controlling device which, when the operation data containing the identification information unique to the transmitter corresponding to oneself is received, controls self operation on the basis of the operation control information contained in the operation data, and controls preparation and transmission of the communication data on the basis of the communication control information contained in the operation data, and which, when the communication data from said another moving machine is received, executes a predetermined processing corresponding to the received communication data, wherein the moving machine controlling device refers to a receiving timing of the operation data transmitted from the transmitter to be combined with oneself or another transmitter, and specifies a self transmission timing which is stipulated, by a predetermined data transmission schedule shared by the transmitter to be combined with oneself, said another transmitter and said another moving machine, such that the transmission timing of the operation data from each of the transmitter to be combined with oneself and said another transmitter and the transmission timing of the communication data from said another moving machine do not overlap each other, and makes the communication data transmitting device transmit the communication data according to the specified transmission timing.

The remote control system of the present invention can be structured if, at each transmitter, devices are provided which ready a transmitter for each moving machine, set the same identification information for a moving machine and a transmitter which form a set, set a common data transmission schedule stipulated such that the transmission timings do not overlap, specify the self transmission timing stipulated by the data transmission schedule by receiving data from another transmitter, and control the transmission timing.

Note that the moving machine of the present invention may include various types of preferable modes in the above-described remote control system. Namely, the aforementioned data transmission schedule may be stipulated such that transmission timing of each of the operation data and the communication data cyclically arrives in a predetermined order. In each cycle, a period in which the moving machine is allowed to transmit the communication data may be stipulated so as to be a time length equal to a period in which said another moving machine is allowed to transmit the communication data. The aforementioned data transmission schedule may be stipulated such that the transmission timing of communication data arrives next after the transmission timing of operation data of the transmitter to be combined with oneself. When the communication data transmitted from said another moving machine is received, the moving machine specifies said another moving machine which transmitted the communication data on the basis of the identification information contained in the operation data received immediately before receipt of the communication data. When the operation data which is transmitted from each of the transmitter to be combined with oneself and said another transmitter or the communication data transmitted from said another moving machine are received, it is judged whether the received data is either the operation data or the communication data by comparing the receiving timing and the transmission timing stipulated by the data transmission schedule.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram showing a schematic structure of a remote control system of the present invention.

FIGS. **2**A and **2**B are a top view and a diagram viewed from a front surface side of a transmitter for a tank model as an embodiment of a transmitter.

FIGS. **3**A and **3**B are a plan view and a side view of a tank model as an embodiment of a moving machine.

FIG. **4** is a diagram showing a circuit structure of the transmitter of FIGS. **2**A and **2**B.

FIG. **5** is a diagram showing a circuit structure of the tank model of FIGS. **3**A and **3**B.

FIG. **6** is a diagram showing a data transmission schedule stipulated such that data transmission timings of the transmitter of FIGS. **2**A and **2**B and the tank model of FIGS. **3**A and **3**B do not overlap one another.

FIG. **7** is a flowchart showing procedures of power-on operation which a microcomputer of the transmitter of FIGS. **2**A and **2**B executes from turning-on of a power source until starting of transmission of self data.

FIG. **8** is a flowchart showing procedures of normal operations which the microcomputer of the transmitter of FIGS. **2**A and **2**B executes after the processing of FIG. **7**.

FIG. **9** is a flowchart showing processing procedures when a microcomputer of the tank model of FIGS. **3**A and **3**B receives data.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** is a diagram showing a schematic structure of a remote control system of the present invention. Note that, in FIG. **1**, a case in which two moving machines **1** . . . **1** are remote-controlled at a same place, and interaction based on communication between the moving machines **1** . . . **1** is caused is supposed.

Transmitters **2** . . . **2** are readied in a one-to-one correspondence with the respective moving machines **1** . . . **1**. The numbers **1**, **2** are set as IDs for the moving machines **1** . . . **1** and the transmitters **2** . . . **2**, respectively. Each moving machine **1** is remote-controlled on the basis of data from the transmitter **2** to which the same ID is given. Infrared radiation is utilized for remote-control of each moving machine **1**. Therefore, a remote control signal light-emitting section **3** is mounted to each transmitter **2**, and a remote control signal light-receiving section **4** is mounted to each moving machine **1**. Moreover, in order to synchronize data the transmission from each transmitter **2**, a remote control signal light-receiving section **5** is mounted to each transmitter **2**. Further, infrared radiation is utilized for communication between the moving machines **1** . . . **1** as well. Therefore, a remote control signal light-emitting section **6** is mounted to each moving machine **1** in order to carry out communication with the other moving machine and the aforementioned remote control signal light-receiving section **4** of the moving machine **1** also receives signals from the remote control signal light-emitting section **6** of the other moving machine **1**.

Hereinafter, as an embodiment of the remote control system of the present invention, a toy remote-controlling a miniature tank model **30** shown in FIGS. **3**A and **3**B by the transmitter **10** shown in FIG. **2** will be described. A user controls the travelling of the tank model **30** and the turning operation of a turret section **32**, and fires at the tank model **30** remote-controlled by another user. Firing is realized by communication utilizing infrared radiation radiated at relatively narrow angles A, B from a barrel **42**. When the tank model **30** receives communication by infrared radiation from another tank model **30**, namely, when the tank model **30** is hit, a predetermined processing for notifying the user of the hit of the tank model **30**, in which, for example, remote control is made impossible for a constant time or an LED is lighted, or a predetermined processing as a penalty in the game, is executed at the tank model **30** which has been hit. This processing can be executed as a different processing according to which tank model **30** the fire has come from.

FIGS. **2**A and **2**B show the transmitter **10** remote controlling the tank model **30**, FIG. **2**A is a top view and FIG. **2**B is a view from the front surface side. As shown in these views, the transmitter **10** has a housing body **11** structured from resin or the like. A cover **11***b* through which infrared radiation passes is provided at a front surface **11***a* of the housing body **11**, and a light-emitting section **12** (corresponding to the remote control signal light-emitting section **3** of FIG. **1**) for transmitting data to the tank model **30** and a light-receiving section **13** (corresponding to the remote control signal light-receiving section **5** of FIG. **1**) for receiving data from other transmitters **10** are provided at the inner side thereof. Further, a set of right and left travelling control levers **14** . . . **14** to be operated for respectively individually controlling the travelling direction and speed of a set of right and left caterpillars **31** . . . **31** (refer to FIG. **3**) provided at the tank model **30**, a turret section control dial **15** to be operated for making the turret section **32** of the tank model **30** turn, a firing key **16** for instructing firing at the tank model **30**, and an ID setting switch **17** for setting the ID of the transmitter **10** are provided at the housing body **11**. Each travelling control lever **14** can switch between forward travelling and reverse travelling of the corresponding caterpillar **31** by being downwardly pivoted forward and backward from a neutral position corresponding to speed **0**, and outputs a speed instruction signal proportional to the amount of downward pivoting. The turret section control dial **15** outputs a turning instruction signal corresponding to a direction of rotation and an amount of rotation when a rotating operation is carried out. The firing key **16** is a push-button switch, and outputs a firing instruction signal when a pushing operation is carried out. The ID setting switch **17** is capable of being operated to switch between four positions corresponding to IDs of **1** through **4**, and outputs signals corresponding to these positions. The ID of the transmitter **10** can be selected from among **1-4** by switch-operating the ID setting switch **17**. Note that, in addition to these, a power source switch **18** switching the ON/OFF of a power source, and an LED **19** showing the operating condition of the transmitter **10**, are also provided at the transmitter **10**.

FIG. **3**A is a plan view of the tank model **30**, and FIG. **3**B is a side view. The tank model **30** has a chassis **33** and a body **34** covered on the top portion of the chassis **33**. Wheels **35** . . . **35** are provided so as to form rows on the left and the right of the chassis **33**, and the caterpillars **31** are stretched over one on each row of the wheels **35** (one at each of the left and the right). At least one among the wheels **35** of each row is mounted to a travelling transmission device **37** via axles **36** . . . **36**, and the other wheels are freely-rotatably mounted to the chassis **33** via the axles **36** . . . **36**. The travelling transmission device **37** transmits the rotation of a motor **38** for travelling, which serves as a driving source, to the axles **36** . . . **36**. The travelling transmission devices **37** and the motors **38** for travelling are provided one at each of the left and the right in correspondence with the set of left and right caterpillars **31** . . . **31**, and the left and right caterpillars **31** can be individually driven. The turret **32** is provided at the upper portion of the body **34**, so as to be able to turn around a shaft **39**. The turret **32** and the shaft **39** can rotate integrally, and the lower end portion of the shaft **39** is mounted to a turret section transmission device **40**. The turret section transmission device **40** transmits rotation of a turret motor **41** as a driving source to the shaft **39**.

The barrel **42** is provided at the turret section **32**. A light-emitting section **43** (corresponding to the remote control signal light-emitting section **6** of FIG. **1**) for transmitting data to another tank model **30** is provided at the front portion of the turret section **32** to which the barrel **42** is mounted. The infrared radiation transmitted from the light-emitting section **43** is led by a condensing body **44** to an optical fiber **45** provided at the barrel **42**. The infrared radiation carried by the optical fiber **45** is emitted at predetermined emission angles A, B, from the front of the barrel **42** in a direction which the barrel **42** faces. Note that, in the present embodiment, because a situation in which the transmitter **10** is operated above the tank model **10** is supposed, if the transmission data is emitted from the barrel **42** in narrow angles A, B, there is no radio interference due to the transmitter **10** receiving the emitted transmission data.

Alight-receiving section **46** (corresponding to the remote control signal light-receiving section **4** of FIG. **1**) for receiving signals from the transmitter **10** and the other tank model **30** is provided at a rear portion of the body **34**. When the light-receiving section **46** receives data transmitted from the light-emitting section **43** of the other tank model **30**, it is considered that the tank model **30** has been hit, and a processing for notifying user that tank model has been hit or a predetermined processing as a penalty in the game is executed. At the front side of the light-receiving section **46**, a cover **47** shielding infrared radiation is provided so as to receive the signal from the other tank model **30** only from a rearward predetermined angle C. In accordance therewith, a game method in which it is judged to be hit only when hit from behind by the other tank model **30** can be realized. Note that the height of the cover **47** is limited such that the light-receiving section **46** can also receive a signal from ahead if the signal is in a range from directly above to an angle D. Accordingly, the cover **47** does not hinder remote control from the transmitter **10** provided above the tank model **30**.

A control device **48**, in which a microprocessor, an oscillator, a memory, a motor driver, and the like are disposed on the same substrate, is provided at the interior of the tank model **30**. The control device **48** judges whether the data sent from the light-receiving section **46** is from the transmitter **10** corresponding to the self tank model **30** or is from another tank model **30**. When it is judged to be data from the transmitter **10** corresponding to the self tank model **30**, on the basis of the data, the control device **48** controls operations of the motors for travelling **38** . . . **38** and the turret motor **41**, and transmits the data from the light-emitting section **43** to another moving machine. When it is judged to be data from another tank model **30**, the control device **48** executes a predetermined processing for the time of being hit.

FIG. **4** shows the circuit structure of the transmitter **10**. Signals corresponding to operations of the travelling control levers **14** . . . **14**, the turret section control dial **15**, the firing key **16**, and the ID setting switch **17** are inputted to a microcomputer **60**. The remote control signal light-emitting section **12** is structured so as to include a light-emitting device such as, for example, an LED or the like, and emits infrared radiation according to remote control data generated by the microcomputer **60**. Note that remote control data of 1 block generated by the microcomputer **60** will be described later (refer to the explanation of FIG. **6**).

On the other hand, the remote control signal light-receiving section **13** shown in FIG. **4** receives infrared radiation transmitted from another transmitter **10**, and outputs a signal, in which the carrier component is removed from the received infrared radiation, to the microcomputer **60**. The microcomputer **60** controls the transmission timing of the self data on the basis of the received data. In this way, setting the transmission timing after receiving the transmitted data of another transmitter **10** is for preventing radio interference due to simultaneous transmission of remote control data from a plurality of the transmitters **10** and a plurality of the tank models **30**.

Note that, a dry cell as a power source, a power source circuit converting the electric current/voltage of the dry cell to a predetermined electric current/voltage, an oscillator providing a clock signal to the microcomputer **60**, a charging circuit or a charging terminal charging a secondary cell as the power source of the tank model **30**, and the like are provided (not shown) at the transmitter **10** in addition to the power source switch **18** shown in FIG. **2**A and the LED **19** showing that the transmitter **10** is in an operating state both.

FIG. **5** shows the circuit structure of a control system mounted at the tank model **30**. The remote control signal light-receiving section **46** for receiving signals from the transmitter **10** and the other tank model **30** is provided at the tank model **30**. The remote control signal light-receiving section **46** outputs a signal, in which the carrier component is removed from the received infrared radiation, to a microcomputer **70**. The microcomputer **70** decodes the signal provided from the remote control signal light-receiving section **46** into remote control data of one block.

When the signal from the transmitter **10** corresponding to the self tank model **30** is received, on the basis of the received data, the microcomputer **70** provides an instruction to drive the motors for travelling **38** . . . **38** to a motor driver **72**, and an instruction to drive the turret motor **41** to a motor driver **73**. Moreover, if there is an instruction to fire in the received data, the microcomputer **70** generates data to be transmitted to the other tank model **30**, and provides an instruction to transmit the data to the remote control signal light-emitting section **43** at a transmission timing based on the time when the data is received from the transmitter **10**. Here, transmitting the data at a transmission timing based on the time when the data is received from the transmitter **10** is for preventing radio interference due to simultaneous transmission of remote control data from a plurality of the transmitters **10** and a plurality of the tank models **30**. The remote control signal light-emitting section **43** is structured so as to include a light-emitting device such as, for example, an LED or the like.

When a signal from the other tank model **30** is received, on the basis of the received data, the microcomputer **70** makes remote control operation impossible for a constant time, or executes a processing for the time of being hit, such as lighting an LED or the like.

A secondary cell as a power source, a power switch switching the ON/OFF of the power source, a power source circuit converting the electric current/voltage of the secondary cell to a predetermined electric current/voltage, an oscillator providing a clock signal to the microcomputer **70**, a nonvolatile memory for holding the ID allocated to the self tank model **30**, and the like are provided (not shown) at the tank model **30** in addition to an LED **74** showing that the tank model **30** is in an operating state.

FIG. **6** shows data transmission schedule stipulated such that the data transmission timings of the respective transmitters **10** and the tank models **30** do not overlap on each other. A time axis **80** at the upper stage shows the data transmission schedule of the transmitters **10**. Between a transmission time (time length T**1**) and a transmission time (time length T**1**) of each transmitter **10**, an interval of time length T**2**, in which none of the transmitters **10** transmits, is provided. The time axis **80** at the lower stage shows the data transmission schedule of the tank models **30**, and a transmission time of each tank model **30** is disposed between the transmission time and the transmission time of each transmitter **10**. Further, transmission data **81** shows the contents of one block of remote control data generated by the transmitter **10**, and transmission data **82** shows the contents of one block of remote control data generated by the tank model **30**. Hereinafter, the contents of the transmission data and the data transmission schedule in the present embodiment will be described with reference to the Figure.

The one block of remote control data generated by the microcomputer **60** of the transmitter **10** is structured from an ID code, control information of the left and right motors for travelling, control information for the turret, and firing instruction information. Data corresponding to an ID selected by the ID switch **17**, for example, data of 2 bits, is set at the ID code portion. At each of the control information portions of the left and right motors for travelling, data of 1 bit designating the driving direction and data of 3 bits designating the speed are set in correspondence with operated positions of the travelling control levers **14**. At the control information for the turret motor, data of 1 bit instructing whether to turn or not and data of 1 bit for designating a direction of rotation are set in correspondence with the operation of the turret section control dial **15**. At the firing instruction information, data of 1 bit designating whether to fire or not is set in correspondence with operation of the firing key **16**. Note that the number of bits of one block of remote control data is always constant. Accordingly, the time needed for transmitting one block of remote control data is constant.

One block of remote control data generated in the microcomputer **70** of the tank model **30** is structured from additional information making the other tank model **30** execute a predetermined processing. In the present embodiment, the additional information is not necessarily needed. However, various changes can be applied by the additional information to the predetermined processing which the hit tank model **30** executes. Note that the number of bits of one block of remote control data is always constant. Accordingly, the time needed for transmitting one block of remote control data is constant.

When four sets of the transmitters **10** for which ID=1-4 are set and the tank models **30** which are objects of control thereof are used at the same time, the transmission timing of each set is set at a period different from those of the other sets, and further, the transmission timings of the respective transmitters **10** and tank models **30** are set to periods different from each other. The length of time in which one set of the transmitter **10** and the tank model **30** transmits remote control signals is T**3**, and each transmitter **10** and each tank model **30** repeats transmission of remote control signals at a period T**4** (=4×T**3**) corresponding to the number of sets×transmission time length T**3**. Further, the transmission timing of each set is shifted in order by T**3** from ID=4. Moreover, the transmission time length T**3** of each set is structured from a transmission time length T**1** of the transmitter **10** and a time length T**2** which follows T**1** and in which transmission of the tank model **30** is allowed. Due to each transmitter **10** and each tank model **30** managing the transmission timing according to such a relationship, it is possible for the transmission periods from the four transmitters **10** and the four tank models **30** to not overlap on each other.

In order to realize such transmission control, for example, if there are the transmitter **10** and the tank model **30** of ID=3 of FIG. **6**, it suffices that the transmission timing is controlled as follows. First, with regard to the transmitter **10** (ID=3), when the transmission data of the transmitter **10** of ID=4 is received at time t**1**, a transmission timer is set to T**2** later, and timer counting starts. This time T**2** is a time in which the tank model **30** of ID=4 is allowed to transmit data. At a time t**2** at which the counting of the transmission timer has passed by time T**2**, the transmitter **10** (ID=3) starts to transmit self data, and completes transmission at time t**3** after T**1** from the state of transmission. At the time of completing transmission, the received data is checked, and it is confirmed that radio interference of the signals has not arisen. Thereafter, the transmission timer counting the next transmission timing is set to T**2**+3×T**3** later, and timer counting is started. If there is an instruction to fire in the received data, the tank model **30** (ID=3), which received the transmission data of the transmitter **10** (ID=3) at time t**3** carries out transmission of data from the completion of receiving to the time T**2** in which the self transmission is allowed. When the transmitter **10** (ID=3) which has counted the transmission timing from time t**3**, receives the transmission data of the transmitter **10** of ID=2 at time t**5**, the transmitter **10** resets the transmission timer to T**2**+2×T**3** later, and starts timer counting. When the transmitter **10** (ID=3) receives the transmission data of the transmitter **10** of ID=1 at time t**7**, the transmitter **10** resets the transmission timer to T2+T3 later, and starts timer counting. Thereafter, when the power source of the transmitter **10** of ID=4 is turned off, or when the data from the transmitter **10** of ID=4 cannot be received due to noise or the like, after receiving the data of ID=1, it suffices that output of self data is started at the point in time when the counting of the transmission timer has passed time T2+T3. Moreover, even when the signal from another transmitter **10** cannot be received, transmission of data can be continued at period T4 (=4×T3) by utilizing the time T2+3×T3 set at the transmission timer at the time of completion of transmission of self data. Further, due to the transmitter **10** being able to continue transmission of data at period T4, the tank model **30**, which sets the transmission timing on the basis of the time when data from the transmitter **10** is received, can continue transmission of data at period T4.

Note that, here, a case in which there are four sets of the transmitters **10** and the tank models **30** was described. However, by adding IDs, the transmission timing can be controlled in the same way even in a case in which there are five or more sets. The period of the transmission timing of each transmitter **10** and each tank model **30** is N×T3 (N is the number of sets). However, a blank period in which data is not transmitted is respectively set between periods in which each transmitter **10** and each tank model **30** are transmitting data, and in accordance therewith, the entire period may be set to be longer than N×T3.

FIG. **7** is a flowchart showing procedures of power-on operation executed by the microcomputer **60** of the transmitter **10** from turning on of the power until start of transmission of self data. When the power is turned on, first, a timer for time-over is set (step **1**). Next, it is judged whether data from another transmitter **10** has been received or not (step S**2**), and when data has been received, it is judged whether or not the ID of the received data is the same as the ID set for the self transmitter **10** (step S**3**). If the IDs match, the routine returns to step S**1**, and judging operations are repeated. In accordance therewith, radio interference in a case in which there are plural transmitters **10** having the same ID is prevented. In step S**3**, when it is judged that the IDs do not match, the self transmission timing is set according to the ID of another transmitter **10** (step S**4**). For example, when the transmitter **10** of ID=3 of FIG. **6** receives data of ID=2, the self transmission timing is set to T2+2×T3 later.

Next, it is judged whether the timer set at step S**1** is time-over or not (step S**5**). If the timer is not time-over, the routine returns to step S**2**. When the time is over, transmission of data remote-controlling the self tank model **30** is started (step S**6**). However, the actual time of starting output is the time at which the transmission timing set at step S**4** has been reached. If no data has been received up until time over, there is single operation, i.e., there is no other transmitter **10**. Therefore, transmission of data is immediately started at step S**6**.

When the processing of step S**6** is completed, the microcomputer **60** controls data transmission according to the procedures of normal operation of FIG. **8**. In normal operation, first, it is judged whether the data from another transmitter **10** has been received or not (step S**11**), and if data has been received, it is judged whether the ID thereof matches the ID set for oneself or not (step S**12**). If the IDs match, the routine returns to the power-on operation of FIG. **7**. On the other hand, when the ID of the received data is different from the self ID, the self transmission timing is set at the transmission timer according to the ID of the received data (step S**13**). Next, it is judged whether the transmission timer is time-up or not (step S**14**), and the routine returns to step S**11** until time is up.

When it is judged that time is up at step S**14**, transmission of the self data is started (step S**15**). At this time, receipt of data is carried out in parallel. Next, it is judged whether the data transmission is completed or not (step S**16**), and if the transmission is completed, the transmitted data and the data received in parallel with the transmission are compared (step S**17**). If the transmitted data and the received data do not coincide, it is judged that radio interference has arisen, and the routine proceeds to the power-on operation of FIG. **7**. If the transmitted data and the received data coincide, because it may be considered that there is no radio interference, the next transmission timing is set at the transmission timer (step S**18**). Thereafter, the routine returns to step S**1**.

FIG. **9** is a flowchart showing receiving processing procedures which the microcomputer **70** of the tank model **30** executes when receiving data from the remote control signal light-receiving section **46**. First, the microcomputer **70** judges whether an ID contained in the received data coincides with an ID allocated to the self tank model **30** (step S**21**). If the IDs match, namely, when it is judged that the received data is the data transmitted from the transmitter **10** corresponding to the self tank model **30**, the timer is set so as to be able to refer to the data transmission schedule of FIG. **6** in which the time axis is corrected on the basis of the time when the data was received (step S**22**).

The transmission timing of the self tank model **30** can be adjusted by the timer, and whether the received data is data from the transmitter **10** or from another tank model **30** can be specified from the time when the data was received. The setting of the timer and the referring to the data transmission schedule may be carried out, for example, as follows. First, when remote control data having the same ID as the ID allocated to the self tank model **30** (i.e., transmission data from the transmitter **10** corresponding to the self) is received, at the time of completion of receiving, the time T**2** is set at the timer and a flag expressing that it is the transmission time of the tank model **30** is set. Thereafter, operation in which, at the point in time when the timer-count has passed by time T**2**, T**1** is reset and the flag is reset, and at the point in time when the timer-count has passed by time T**1**, time T**2** is reset and the flag is set, is repeated. In accordance therewith, whether the time of receiving the data is the transmission time of the transmitter **10** or the transmission time of the tank model **30** can be distinguished. Moreover, if a counter variable is prepared, the counter variable is initialized in the transmission time of the self tank model **30**. Thereafter, by increasing the counter variable each time the flag, which expresses that it is the transmission time of the tank model **30**, is set, even when the transmission data from the transmitter **10** corresponding to oneself is cut-off, the self transmission timing can be known, and the ID of the received remote control data can be specified.

After the timer is set at step S**22**, it is judged whether there is a firing instruction or not in the firing instruction information contained in the received data (step S**23**). When there is a firing instruction, data transmitted to another tank model **30** is generated, and the data is transmitted at a predetermined timing (step S**24**). Thereafter, on the basis of the left and right motor for travelling control information and the turret motor control information contained the received data, motor-control is carried out (step S**25**), and the routine waits for the next receipt.

At step S**21**, if the ID contained in the received data does not match the ID allocated to the self tank model **30**, the receiving time and the data transmission schedule set at step S**22** are compared, and it is judged whether the receiving time is the transmitting time of another tank model **30** or not (step S**26**). When it is judged that the receiving time is not the transmission time of the tank model **30** (namely, that it is the transmission data from the transmitter **10** corresponding to another tank model **30**), T**2** is reset at the timer for referring to the data transmission schedule, and thereafter, due to the counting and setting of T**2** and T**1** being repeated, the data transmission schedule is corrected (step S**27**). Next, the ID contained in the received data is set to a variable for storing the ID of the received data (step S**28**).

At step S**26**, when it is judged to be the transmission time of another tank model **30**, the ID substituted in at step S**28** is referred to. In the present embodiment, as shown in FIG. **6**, after the transmission time of the transmitter **10**, the transmission time of the corresponding tank model **30** follows. Therefore, the ID of the tank model **30** which fired can be specified by the referred-to ID (step S**29**). Next, on the basis of the ID of the tank model **30** which fired, processing at the time of being hit, such as making remote control impossible for a constant time, lighting an LED, or the like, is executed (step S**29**). Note that judgement as to whether it is data transmitted from another tank model **30** or not at step S**26** may be executed by 1 bit of information, for distinguishing whether it is data from the transmitter **10** or data from the tank model **30**, being added to each transmission data of the transmitter **10** and the tank model **30**, and the microcomputer **70** referring to the information contained the received data. Specification of data transmitted from which tank model **30** may be carried out by adding to the transmission data the ID allocated to the transmitting tank model **30**, and the microcomputer **70** referring to the ID contained in the received data.

The present invention is not limited to the above-described embodiment, and may be implemented in various forms. For example, the moving machine is not limited to a tank, and may be a machine imitating various moving bodies. Interaction based on communication between the moving machines is not limited to firing, and may be conversation or the like. The light-receiving section of the moving machines is not limited to one, and a plurality of light-receiving sections may be provided. One part of the plurality of light-receiving sections may be used for receiving transmission data from a transmitter, and the other light-receiving sections may be used for receiving transmission data from another moving machine. The transmitter may be hand-holdable by an operator, or may be a type which is placed on a floor. A specific program may be installed into a portable machine such as a portable game machine or a portable telephone, and it may be made to function as a transmitter.

As described above, according to a remote control system of the present invention, each transmitter, by receiving data transmitted from another transmitter, or each moving machine, by referring to receiving timing of data transmitted from each transmitter, can transmit self data according to a data transmission schedule stipulated such that transmission timings of each transmitter and each moving machine do not overlap. Accordingly, the data from each transmitter and the data from each moving machine can be transmitted on the same carrier signal, and, at each moving machine, the sharing of a receiving device and a processing system of signals from the transmitter and signals from over moving machines can be advanced. In accordance therewith, without leading to complexity of a structure of the moving machine and an increase of electric power consumption, a plurality of moving machines can be remote-controlled and interaction based on communication can be brought about among the moving machines.

The invention claimed is:

1. A remote control system comprising:

a plurality of transmitters;

a plurality of moving machines, which are configured to correspond respectively to the plurality of transmitters, said moving machines being individually controlled by the plurality of transmitters, and said system causing interactions between the moving machines based on communication between the moving machines,

wherein a transmitter from the plurality of transmitters comprises:

an operation data preparing device for preparing operation data including identification information which uniquely identifies each of the plurality of transmitters, operation control information for controlling an operation of one of the plurality of moving machines, and communication control information for controlling the communication between the moving machines;

an operation data transmitting device for transmitting the operation data;

an operation data receiving device for receiving the operation data transmitted from one of the other transmitters;

a transmission timing setting device for setting a transmission timing of self operation data based on the identification information contained in the received operation data; and

an operation data transmission controlling device for making the data transmitting device transmit the operation data according to the set transmission timing;

wherein a moving machine from the plurality of moving machines comprises:

a communication data preparing device for preparing communication data for making one of the other moving machines execute a predetermined process;

a communication data transmitting device for transmitting the communication data;

a data receiving device for receiving the operation data transmitted from each of the plurality of transmitters and the communication data transmitted from said one of the other moving machines; and

a moving machine controlling device for controlling self-operation based on the operation control information in the operation data and for controlling preparation and transmission of the communication data based on the communication control information in the operation data after receiving the operation data from one of the transmitters, the operation data containing the identification information unique to the transmitter corresponded to oneself, and for executing the predetermined process corresponding to the communication data after receiving the communication data from said one of the other moving machines,

wherein a common data transmission schedule is set for the plurality of transmitters and moving machines, the data transmission schedule stipulates that the transmission timing of each of the operation data and the communication data does not overlap,

the transmission timing setting device of each of the plurality of transmitters refers to the identification information contained in the operation data from said one of other transmitters, and specifies the transmission timing of self operation data stipulated by the data transmission schedule, and the moving machine controlling device refers to a receiving timing of the operation data transmitted from at least one of the plurality of transmitters, and specifies a transmission timing of self communication data stipulated by the data transmission schedule, and makes the communication data transmitting device transmit the communication data according to the specified transmission timing.

2. The remote control system according to claim **1**, wherein the data transmission schedule stipulates that the transmission timing of each of the operation data and the communication data cyclically arrives in a predetermined order.

3. The remote control system according to claim **2**, wherein, in each cycle, periods in which the plurality of transmitters are allowed to transmit the operation data, respectively, are stipulated so as to have time lengths equal to each other, and periods in which the plurality of moving machines are allowed to transmit the communication data, respectively, are stipulated so as to have time lengths equal to each other.

4. The remote control system according to claim **3**, wherein the data transmission schedule is stipulated such that the transmission timing of the communication data of one moving machine arrives next after the transmission timing of the operation data of one transmitters, which corresponds to said one moving machine.

5. The remote control system according to claim **4**, wherein, when said one moving machine receives the communication data transmitted from one other moving machine, said one moving machine specifies said other moving machine on the basis of the identification information contained in the operation data received immediately before receipt of the communication data transmitted from one of the other transmitters.

6. The remote control system according to claim **1**, wherein, when each of the plurality of moving machines receives the operation data transmitted from each of the plurality of transmitters or the communication data transmitted from each of the plurality of moving machines, each of the plurality of moving machines judges whether the received data is either the operation data or the communication data by comparing a receiving timing of the received data and the transmission timing of each of the plurality of transmitters and each of the plurality of moving machines stipulated by the data transmission schedule.

7. A moving machine which corresponds to a transmitter configured to transmit operation data including identification information for identifying oneself, operation control information for controlling an operation of one of objects of control, and communication control information for controlling communication between said objects of control, and which is used as said one of the objects of control, the moving machine comprising:

a communication data preparing device which prepares communication data that instructs another moving machine to execute a predetermined process;

a communication data transmitting device which transmits the communication data;

a data receiving device which receives the operation data transmitted from the transmitter and the communication data transmitted from another moving machine; and

a moving machine controlling device which, when the operation data containing the identification information unique to the transmitter corresponding to the moving machine is received, controls an operation of itself on the basis of the operation control information contained in the operation data, and controls preparation and transmission of the communication data on the basis of the communication control information contained in the operation data, and which, when the communication data from said another moving machine is received, executes a predetermined process corresponding to the received communication data,

wherein the moving machine controlling device refers to a receiving timing of the operation data transmitted from the transmitter to be combined with oneself or another transmitter, and specifies a self transmission timing which is stipulated, by a predetermined data transmission schedule shared by the transmitter to be combined with oneself, said another transmitter and said another moving machine, such that the transmission timing of the operation data from each of the transmitter to be combined with oneself and said another transmitter and the transmission timing of the communication data from said another moving machine do not overlap each other, and makes the communication data transmitting device transmit the communication data according to the specified transmission timing.

8. The moving machine according to claim **7**, wherein the data transmission schedule is stipulated such that transmission timing of each of the operation data and the communication data cyclically arrives in a predetermined order.

9. The moving machine according to claim **8**, wherein, in each cycle, a period in which the moving machine is allowed to transmit the communication data is stipulated so as to be a time length equal to a period in which said another moving machine is allowed to transmit the communication data.

10. The moving machine according to claim **9**, wherein the data transmission schedule is stipulated such that the transmission timing of communication data arrives next after the transmission timing of operation data of the transmitter to be combined with oneself.

11. The moving machine according to claim **10**, wherein, when the communication data transmitted from said another moving machine is received, the moving machine specifies said another moving machine which transmitted the communication data on the basis of the identification information contained in the operation data received immediately before receipt of the communication data.

12. The moving machine according to claim **7**, wherein, when the operation data which is transmitted from each of the transmitter to be combined with oneself and said another transmitter or the communication data transmitted from said another moving machine are received, it is judged whether the received data is either the operation data or the communication data by comparing the receiving timing and the transmission timing stipulated by the data transmission schedule.

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